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THE CRAWFISHES OF THE STATE OF INDIANA.

BY W. P. HAY, M. S.

PROF. W. S. BLATCHLEY,
Indianapolis, Ind.:

DEAR SIR—I herewith present to you my report on the crawfishes of the State of Indiana In the following pages I have brought together a set of descriptions taken from Indiana types of the species which occur within the limits of the State. Keeping constantly in mind the needs of the teacher and student, I have made my descriptions full and at the same time as simple as the subject would permit. As a further aid in identification I have prepared for each species a set of camera lucida drawings to show the characteristic features. The analytical key will also be found of the greatest assistance to the worker. Along with the descriptions I have for each species mentioned the various points in our State in which it has been taken. Until the distribution of the crawfishes is more thoroughly worked up it would hardly be safe to express in general terms the extent of country over which a species is to be found.

I have also added in most cases a few notes regarding the habits. Comparatively few observations have been made in this line and I regret exceedingly that that part of my paper has been curtailed. Throughout my work I have had constantly at my hand the works of Drs. Hagen and Faxon on the crawfishes of North America, and I have used them freely whenever I have had occasion to do so.

To Dr. Faxon, I wish to express my thanks for his suggestions regarding the new species herein described.

To the following gentlemen I am very much indebted for the loan of specimens and other favors, without which it would have been almost impossible to have completed my work: Prof. B. M. Davis, Butler College; Dr. C. H. Eigenmann, Indiana State University; Prof. A. C. Yoder, Vincennes High School; Prof. J. T. Scovell, Terre Haute High School; Dr. O. P. Hay, Field Columbian Museum; Prof. W. W. Wright, Oberlin College, Ohio; Prof. B. W. Evermann, U. S. Fish Commission; Dr. G. Brown Goode, Director, and Mr. J. E. Benedict, Assistant Curator, Department of Marine Invertebrates, U. S. National Museum.

WASHINGTON, D. C., December, 1895.

INTRODUCTION.

The genus Cambarus.—This genus, which was proposed by Erichson in 1846 to contain certain peculiar crawfishes of the American continent, forms one division of the family *Astacidæ*, a family which is very closely related to the *Homaridæ*, or lobsters, and from which they are distinguished by the fact that the segment bearing the hindmost pair of walking legs is not immovably fused to the one preceding it, but is capable of motion back and forth.

The crawfishes then may be briefly described as long-tailed, ten-legged crustaceans (contrasted with the crabs) having the anterior portion of the body covered with a shell or *carapace*, which ends in front in a prominent beak or *rostrum*, and which is divided near the middle by a transverse groove, *cervical groove*. The first pair of walking legs is much enlarged, end in pincers and serve as organs of offense and defense. The second and third pairs of walking legs are much smaller, but likewise end in pincers. The fourth and fifth pairs are not so provided and the latter pair of legs are borne on a segment which is not fused with the one in front. The family is divided into two groups or sub-families.

1. The *Astacinæ*, which includes those crawfishes having the first pair of abdominal appendages in the male modified to form sexual organs. This group is divided into two genera, *Cambarus* and *Astacus*, both of which are found, so far as known, only in the northern hemisphere.

2. The *Parastacinæ*, including those crawfishes in which the first pair of abdominal appendages in both sexes is entirely wanting. This group is divided, at present, into six genera, *Astacoides*, *Cheraps*, *Engaeus*, *Paranephrops*, *Astacopsis* and *Parastacus*, all of which are found south of the equator and which probably never range far north of it.

In North America both genera of the *Astacinae* are found. *Astacus*, however, occurs only west of the Rocky Mountains and in the Yellowstone River, while all the species to the eastward belong to the genus *Cambarus*. *Cambarus* is distinguishable from *Astacus* by the following characters: (1) the last body segment is not provided with a gill; (2) in the male one or two pairs of thoracic legs bear on the lower surface of the third segment a strong re-curved projection or hook, and the first pair of abdominal appendages end in two distinct branches; (3) in the female there is on the lower surface of the

body, between the fourth and fifth pairs of walking legs, a peculiar irregularly conical elevation with a depressed and deeply furrowed apex—the *annulus ventralis.*

The number of described species of *Cambarus* is at present sixty-one; the only form which occurs beyond the limits of the North American continent being *C. typhlobius* Jos., a blind species from the caves of Carniola, in Austria. Of the genus *Astacus* only fourteen species are known from Europe, Asia and North America together.

In habits there is a greater variation among the species of crawfishes than is generally supposed. Some inhabit only streams of pure running water, others are to be looked for in lakes and standing pools, and others visit the streams only during the spawning season. Some species lead a roving life; others spend most of their time hiding under stones or other objects in the water; others dig burrows into the banks of the stream and from these tunnels sally forth to catch some unfortunate animal as it passes by; three of our species, at least, dig complicated burrows, often some distance from the water, and erect over the holes a carefully constructed chimney.

The food of these animals probably varies to almost as great an extent as their habits, but concerning this but little is known. Some forms are undoubtedly carnivorous, while for others the evidence, which, however, is scant, points toward a diet that is very largely vegetable.

Specific Characters. In the genus *Cambarus* the variations among the individuals are frequently perplexing; they are greater than among most animals.

A crawfish apparently grows indefinitely, and with the increase in age come more or less marked changes, not only in size but in the form and proportions of the parts. In species which in the adult condition are smooth the young are very apt to show spines on the rostrum or sides of the carapace. In species which bear spines the older individuals are often better provided with these means of defense than the young

Accidental variations are always to be looked for. As is well known, a crawfish is able to reproduce lost appendages, and as appendages are very easily lost it is no unusual thing to find the large claw on one side very unlike its mate on the other side, or to find one antenna long and slender, while the other is a mere stump. These variations will never be misleading unless they happen to be exactly alike on the two sides, a thing which sometimes occurs.

Between the two sexes there is a difference which extends to almost all parts of the body. The female has a wider abdomen bearing stronger swimmerets, usually a less developed armature, and weaker and smaller claws. The amount of these sexual differences is variable, however, owing to the fact that for each species there are two forms of the male; of which one is more highly developed, better armed and fitted for

sexual union with the female. The other is apparently sterile and bears a close resemblance to the opposite sex. In a paper "On the so-called Dimorphism in the Genus Cambarus" (Amer. Jour. Sci., xxvii, Jan. 1884), Dr. Faxon calls attention to the discovery that these two forms are simply phases in the life of the same individual; that during the pairing season the characteristics of the "first form" are assumed, and after a completion of the sexual union, a moult brings the animal into the "second form," another moult being necessary before the animal is again capable of reproduction.

For dividing the genus into subordinate groups various characters have been drawn into service, the most satisfactory, however, are those employed by Dr. Faxon, viz., the number of hooked legs in conjunction with the character of the first abdominal appendages of the male. As will be seen, for the successful identification of any species, specimens of the female alone will be of little value. Such a method is open to criticism, but it is the only one which seems to be a natural one, and, after all, the difficulties are more imaginary than real.

The following analytical key will facilitate the identification of the fifteen species known to occur in Indiana:

1. Third segment of third and fourth pairs of legs of males hooked.
   - a. Eyes well developed. *C. blandingii acutus* (p. 481).
   - b. Eyes atrophied.
     1. Carapace and rostrum with spines. *C. pellucidus* (p. 482).
     2. Carapace and rostrum smooth. *C. pellucidus testii* (p. 484).
2. Third segment of only the third pair of legs of male hooked.
   - A. First pair of abdominal appendages of the male claviform, the outer part truncate and terminated by three small teeth, inner part ending in a slender spine. *C. gracilis* (p. 486).
   - B. First pair of abdominal appendages of the male ending in two thick falciform teeth, the larger of which is formed by the outer part of the appendage, the smaller by the inner part.
     1. Areola linear or obliterated in the middle.
        - a. Anterior border of the carapace with a projecting angle below the eye. *C. diogenes* (p. 489).
        - b. Anterior border of the carapace without a projecting suborbital angle. *C. argillicola* (p. 492).
     2. Areola moderately wide. *C. bartonii* (p. 487).
   - C. First pair of abdominal appendages of the male furciform, ending in two nearly straight branches.
     1. Rostrum without lateral spines. *C. immunis* (p. 501).

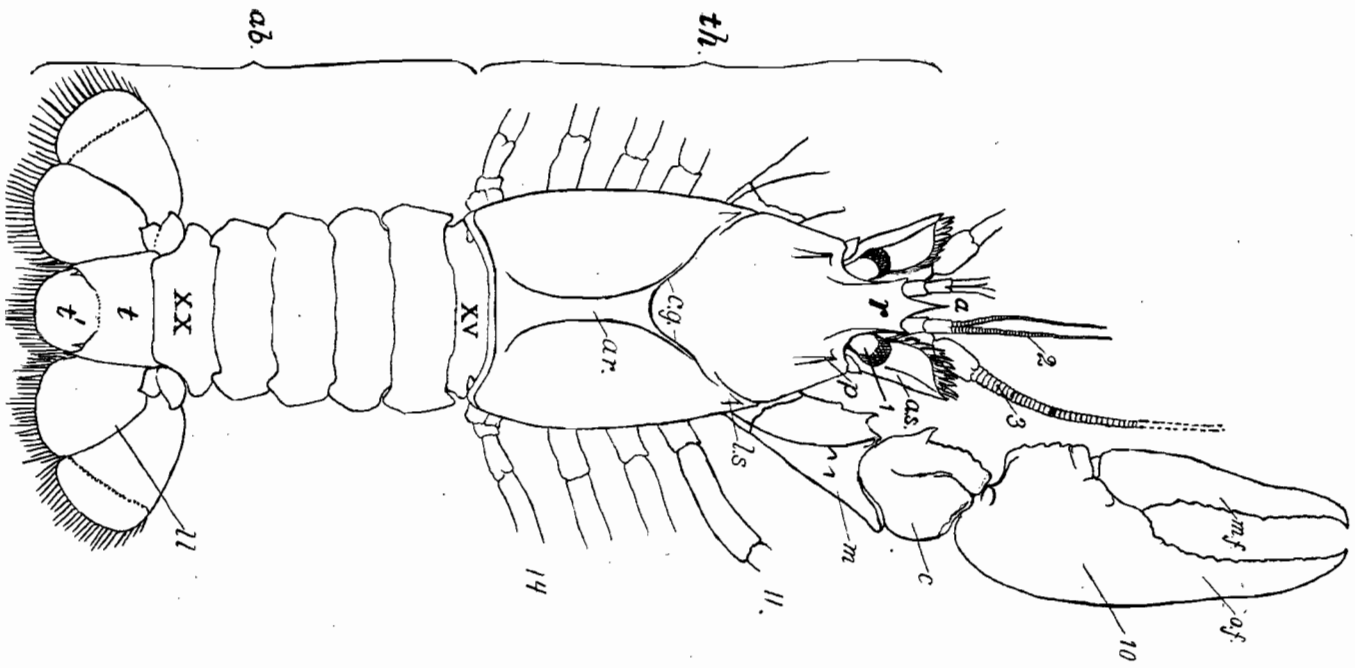

FIG. 1. Dorsal view of *Cambarus rusticus*, male. 1, eye; 2, antennule; 3, antennæ; 10, chela; 11, second pair of walking legs; 14, fifth pair of walking legs; XV–XX, segments of the abdomen; *a*, acumen of rostrum; *ab*, abdomen; *a. s.*, antennal scale; *ar*, areola; *c. g.*, cervical groove; *c*, carpus; *ll*, lateral lobe of tail fin; *l. s*, lateral spine; *m*, meros; *m. f.*, movable finger; *o. f.*, outer finger; *p*, post orbital spine; *t.* proximal, *t'*, distal segments of telson; *th*, thorax covered by the carapace.

2. Rostrum with lateral spines.
   a. Rostrum with a median longitudinal ridge above.
      C. propinquus (p. 497).
   b. Rostrum without such a ridge.

1. First pair of abdominal appendages very long and deeply cleft, reaching the base of the chelipeds when the abdomen is flexed. *C. putnami* (p. 504).
2. First pair of abdominal appendages shorter, not reaching the base of the chelipeds.
   a. Sides of the rostrum concave.
      1. Incurvation decided. *C. rusticus* (p. 503).
      2. Incurvation slight. *C. indianensis* (p. 494).
   b. Sides of the rostrum not concave.
      1. Rami of the first abdominal appendages strongly recurved near the tips.
         C. immunis spinirostris (p. 502).
      2. Rami of the first abdominal appendages nearly straight.
         a. Rami long and slender. *C. virilis* (p. 499).
         b. Rami short and thick. *C. sloanii* (p. 495).

CAMBARUS BLANDINGII ACUTUS (Girard).

Cambarus acutus Girard, Proc. Acad. Nat. Sci., Phila., VI, 91, 1852.
Cambarus acutus Hagen, Ill. Cat. Mus. Comp. Zoöl. No. III, p. 35.
Cambarus blandingii var. *acuta* Faxon, Mem. Mus. Comp. Zoöl. X, No. 4, 1885, p. 20.

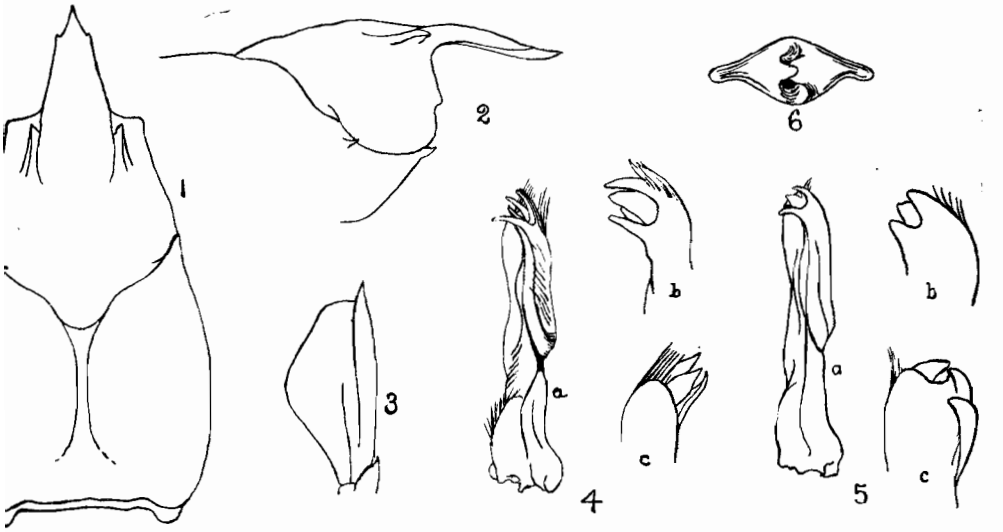

FIG. 2. *Cambarus blandingii acutus.*—1, carapace from above; 2, carapace from side; 3, antennal scale; 4, first abdominal appendage, male, F. I; 5, first abdominal appendage, male, F. II; 6, annulus ventralis.

Male, Form I.—Rostrum triangular, broad at the base, with sharp, raised and convex margins; acumen short, lateral teeth small; post orbital spine small, ridges grooved externally, nearly parallel in front, but strongly converging behind. Carapace oval, not flattened, nearly smooth about the base of the rostrum, otherwise strongly tuberculate. Cervical groove rather deep, sinuate, broken on the sides and ending above the small branchiostegal spine. Areola rather narrow. Abdomen shorter than the cephalothorax, well arched, and with nearly parallel sides. Telson with the posterior border sinuate, proximal segment bispinose on each side. Tail fin when extended equal in width to length of abdomen. Antennæ slender, shorter than the body; scale slightly longer than the rostrum, widest near the middle, truncate at apex, with a short, terminal spine, border inflated Epistoma triangular and densely fringed with hairs. Third maxillipeds, hairy below, within and without. Chelipeds slender; meros, in perfect specimens, surpassing the tip of the rostrum;

chelæ slender, rounded and heavily granulate or squamous, internal margin strongly dentate; fingers slender, external one nearly straight, internal one sinuate. Carpus long, nearly flat above, inner surface with several strong spines. Meros slender, a ridge of small blunt spines above and an irregular double line of larger spines below. Third and fourth pairs of legs hooked, the hooks on the third pair being the largest and strongest. First pair of abdominal appendages short, straight and thick, apex plainly bifid; external part the strongest, bearing, at the extremity, two curved, acute, horny spines and a pencil of hairs; internal portion ending in two slender spines.

Male, Form II.—Similar in general to Form I, but with smaller hooks on the third and fourth pairs of legs. The first abdominal appendages have an articulation near the base, apical teeth on both the internal and external portions small and blunt, and the pencil of hairs almost gone.

Female.—Similar, but with shorter chelæ and smoother carapace. Annulus ventralis much wider than long, with a deep longitudinal fissure dividing it, the sides of the fissure near the middle being raised into a prominent elevation or tubercle on each side, and the tubercle of one side often overhanging that of the other.

Measurements of male, Form I—Length, 93 mm.; carapace, 49 mm.; abdomen, 44 mm.; rostrum to cervical groove, 31.5 mm.; rostrum, 12 mm.; breadth of rostrum, 7 mm.; areola, 2 mm.; carapace, 23 mm.; second abdominal segment, 19 mm.

Indiana Localities—Wheatland and Vincennes, Knox county; Turkey Lake, Kosciusko county; Lake Maxinkuckee, Marshall county; Kankakee River, Lake county; Terre Haute, Vigo county.

Cambarus blandingii acutus is to be looked for in almost any character of surroundings. Usually, however, they occur in running water where there is an abundant supply of vegetation.

Cambarus pellucidus (Tellkampf).

Astacus pellucidus Tellkampf, Arch. Anat. Physiol. u. Wissensch. Med., 1844, p. 383.

Cambarus pellucidus Hagen, Ill. Cat. Mus. Comp. Zoöl., No. III, p. 55, 1870.

Cambarus pellucidus Faxon, Mem. Mus. Comp. Zoöl., X, No. 4, p. 40, 1885.

Cambarus pellucidus Hay, Proc. U. S. Nat. Mus., Vol. XVI, pp. 283–286, 1893.

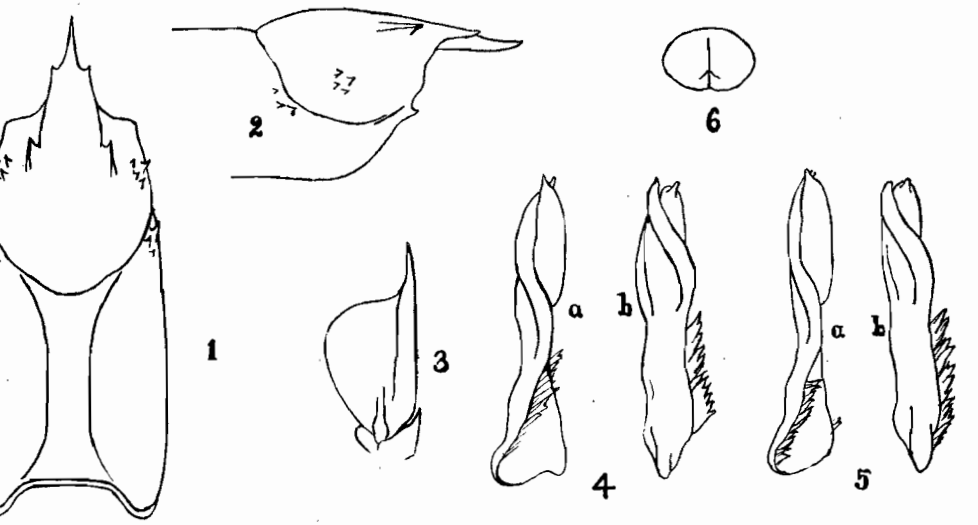

FIG. 3. *Cambarus pellucidus.*—1 and 2, carapace from above and side; 3, antennal scale; 4, first abdominal appendage male, F. I; 5, same, F. II; 6, annulus ventralis.

Male, Form I.—Rostrum broad, smooth, and with a shallow foveola at the base; margins raised and somewhat converging; rostral spines well developed, slightly turned outward; acumen usually very long and slender. Postorbital spines acute, the ridges very low. Carapace cylindrical, smooth above, granulate on the sides; lateral spines numerous and directed obliquely outwards; areola long, sides nearly parallel. Abdomen with nearly parallel sides, pleural angles obtuse; telson tapering slightly to the evenly rounded extremity, proximal segment bi-spinose on each side. Eyes atrophied, appearing as small white lumps hidden beneath the rostrum. Antennæ longer than the body, scale about as long as the rostrum, widest near the end. Epistoma short and broad, the margins straight and swollen. Third maxillipeds hairy within Chelipeds slender and long, the distal end of the meros reaching the tip of the rostrum. Hand slender, covered with granulations which on the inner border are larger and tooth-like; movable finger nearly straight, the tip strongly incurved. Carpus long, only slightly grooved above, the inner surface bearing several small spines. Meros with a longitudinal band of spines on both upper and lower surfaces. Hooks on the third and fourth pairs of legs very strong and tooth-like, those on the third legs strongest. First pair of abdominal appendages short, straight and twisted at the apex, inner ramus bearing on its apex a small outwardly directed tooth, which, as well as the tip of the outer ramus, is brown and corneous.

Male, Form II.—Very similar, the hooks on the third and fourth pairs of legs are not so strong, the first abdominal appendages have a smaller apical tooth and the tips of the rami are not corneous.

Female.—More slender, with weaker chelæ. Annulus ventralis an elliptical papilla crossed by a narrow, longitudinal line, which on the posterior face gives off a small oblique branch on each side.

Measurements of male, Form I—Length, 68 mm.; carapace, 32 mm.; abdomen, 36 mm.; rostrum to cervical groove, 19.5 mm.; rostrum, 8.5 mm.; breadth of rostrum, 4 mm.; carapace, 12 mm.; areola, 2 mm.; 2d abdominal segment, 11 5 mm.

Color in life a translucent creamy white, the stomach showing through as a bluish spot in front of the cervical groove.

Indiana Localities.—Shiloh Cave, Down's Cave, Dunnihue's Cave, Connelly's Cave, Donelson's Cave, Lawrence county; cave at Clifty, Bartholomew county; cave near Paoli, and in Lost River, Orange county; Wyandotte Cave, Wildcat Cave, small cave near Wyandotte, and Marengo Cave (?), Crawford county; "caves in Harrison county;" caves near Madison, Jefferson county.

Cambarus pellucidus was first described from specimens from the Mammoth Cave of Kentucky. It was discovered to occur in Wyandotte Cave by Prof. E. D. Cope, in 1871, and in 1872 he described it as a new species and genus *Orconectes inermis*, establishing the new genus to contain all the blind crawfishes.

The generic differentiation met with no acceptance, and the form "*inermis*" is now hardly recognized even as a variety of pellucidus. The species is extremely variable in such points as the length of the rostrum and the arrangement of spines This variation I have found most marked in specimens taken from the caves of Lawrence and Monroe counties. In Shiloh Cave, near Bedford, I have collected a series of between forty and fifty specimens. Among them I find individuals which agree almost perfectly with specimens from Mammoth Cave, and other individuals which are almost entirely destitute of spines. From the caves of Monroe county comes a peculiar form which is entirely without spines on the carapace. So constant is this feature and so different is the appearance of these specimens that I have separated them as a subspecies.

CAMBARUS PELLUCIDUS TESTII Hay

Cambarus pellucidus Packard. Monograph Cave Animals of N. A., Mem. Nat. Acad. Sci. Vol. IX, No. 9, p. 16, 1888.

Cambarus pellucidus Faxon. Notes on N. A. Crayfishes, Proc. U. S. Nat. Museum, Vol. XII, p. 621, 1890.

Cambarus pellucidus testii Hay. Proc. U. S. Nat. Museum, Vol. XVI, pp. 283–286, 1893.

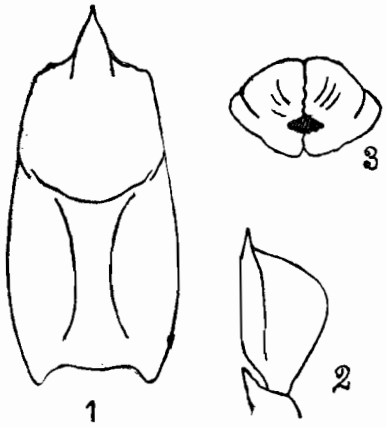

FIG. 4. *Cambarus pellucidus testii.*—1, carapace from above; 2, antennal scale; 3, annulus ventralis.

Differs from *C. pellucidus* in the great reduction of the spines. Instead of being rough and very spiny, as the typical specimens from Mammoth Cave are described as being, they are entirely smooth. The lateral rostral spines are wholly gone, the post-orbital ridges are smooth and rounded at the end, and the lateral spines of the carapace are at best represented by a few low, smooth tubercles.

The rostrum is shortened still more than in Prof. Cope's *inermis*, and instead of being "deeply sinuated to form the acumen," runs to a point in a gradual curve, very much resembling in this respect *C. acuminatus*.

The portion of the carapace in front of the cervical groove is shorter than in the average of specimens from Shiloh Cave, and conspicuously shorter than in specimens from Mammoth Cave. In respect to the hooks on the legs of the males I find the species variable. In none do I find hooks on both legs of the fourth pair; generally they are wholly wanting, but in some there is a small tubercle on one leg, which is missing from the other The hooks on the third pair of legs are of a slightly different form from those of specimens from Shiloh or Wyandotte. They are shorter, blunter, and not curved.

The first abdominal appendages of the males do not differ in any respect from those of the typical *C. pellucidus*.

In the female the annulus ventralis shows marked differences from the typical forms.

The antennal scale, also, is different in form, and especially in length.

Indiana Localities—Mayfield's and Truett's Caves, Monroe county.

CAMBARUS GRACILIS Bundy.

Cambarus gracilis Bundy, Bull. Ill. Mus. Nat. Hist., No. 1, p. 5, 1876.
Cambarus gracilis Faxon, Mem. Mus. Comp. Zoöl., Vol. X., No. 4, p. 56, 1885.

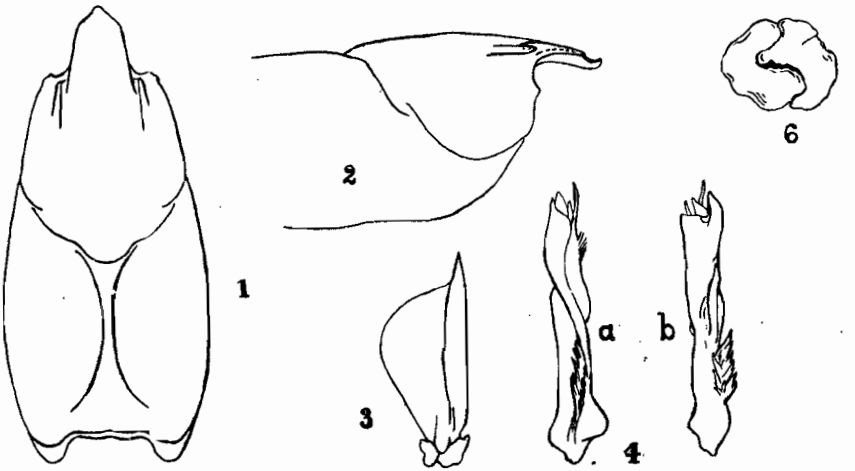

FIG. 5. *Cambarus gracilis*—1 and 2, carapace from above and side; 3, antennal scale; 4, first abdominal appendage, male F. I; 6, annulus ventralis.

Male, Form I.—Rostrum of moderate length, decurved, much hollowed out, with a small foveola at base; margins prominent, converging slightly to near the tip, where they suddenly turn inward to form the short acumen, sides of the acumen slightly concave. Post-orbital ridges grooved on outer face, without spines in front, and slightly inflated at the posterior ends. Cephalothorax long and compressed. Carapace nearly smooth above, granulate on the sides, a small projecting angle just below the eye. Cervical groove markedly sinuate, broken on the sides; no lateral or branchiostegal spine; areola linear, with a small anterior and a larger posterior triangular space. Abdomen shorter than the cephalothorax; pleural angles truncate; telson short; proximal segment uni- or bi-spinose on each side, distal segment rounded; inner blade of swimmeret with a short curved ridge on the inner margin, the main longitudinal rib not reaching the distal end of the blade. Antennæ slender, about as long as distance from cervical groove to end of telson; scale small, about as long as rostrum, widest beyond the middle; terminal spine acute. Epistoma triangular, sides straight or convex, anterior angle truncate or dentate. Inner face of third maxillipeds furnished with long hairs. Chelipeds stout and rather short; chelæ swollen and covered with punctations; inner margin serrate; fingers somewhat

flattened and decurved; movable finger sinuate, serrate on external margin near the base and bearing one or more strong tubercles on the internal margin, tip incurved, acute and corneous; outer finger nearly straight, with a large tooth on the internal margin near the base; tip acute and corneous. Carpus triangular, with a large tooth and two or three small tubercles on the inner face and several strong teeth below, furrow on upper surface deep and broad. Meros with a few spines above near the distal end, lower surface with two rows of small spines. The two distal joints of the second, fourth, and fifth legs hairy. Third pair of legs hooked. Sternum hairy. First pair of abdominal appendages rather long (reaching to the base of the third pair of legs), twisted, internal portion short, terminated by a long, slender spine and bearing a prominent tuft of hair near the middle; external portion of appendage notched at the apex; posterior portion prolonged into a flattened, corneous, tooth-like process; anterior portion acute and tooth-like. Between these two elevations are two slender teeth.

Male, Form II.—Not known.

Female.—Very similar to the male. Annulus ventralis movable, composed of two interlocked falciform pieces, highest on the outer margins. Openings of oviducts surrounded by long hairs.

Measurements of male, Form I.—Length, 62; carapace, 32.5; abdomen, 29.5; rostrum to cervical groove, 19; rostrum, 6. Breadth—carapace, 14; rostrum, 4.25; second abdominal segment, 12.

Cambarus gracilis, as far as I have been able to learn, has never been taken in Indiana, and, therefore, ought possibly to be excluded from this list. I have lately, however, received a specimen of this species from the neighborhood of Chicago, and I think there can be no doubt of its occurrence in the prairie region in the western portion of our State. In its habits it is a burrower, coming forth probably only during the breeding season, in the early spring, when it frequents the water courses.

Cambarus bartonii (Fabricius).

(?) *Astacus bartonii* Fabricius, Suppl. Entomolog. Systemat., p. 407, 1798.

Cambarus bartonii Hagen, Ill. Cat. Mus. Comp. Zoöl., No. III, p. 75, 1870.

Cambarus bartonii Faxon, Mem. Mus. Comp. Zoöl., Vol. X, No. 4, p. 59, 1885.

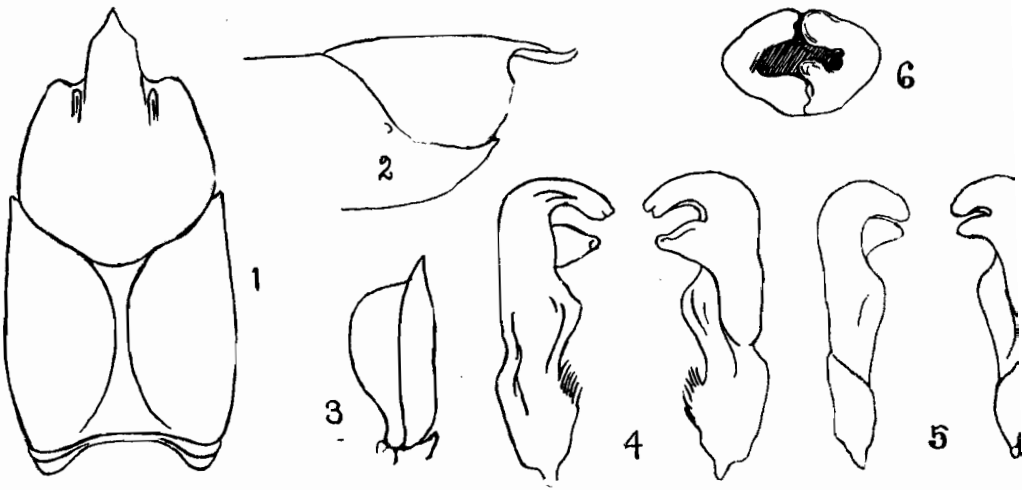

FIG. 6. *Cambarus bartonii.*—1 and 2, carapace from above and from the side; 3, antennal scale; 4, first abdominal appendages, male, F. I; 5, same, F. II; 6, annulus ventralis.

Male, Form I.—Rostrum short, broad, and little excavated; margins low, converging; acumen short, with concave sides and brown, upturned horny tip. Post-orbital ridges low, short, grooved on outer face. Carapace much flattened above and quite smooth, slightly granulate on the sides, this most marked in front; lateral spines very minute, branchiostegal spine small; lateral line sinuous, not broken on the sides; areola narrow, anterior triangular space almost obsolete. Abdomen broad, about as long as carapace, telson tapering, proximal segment bispinose on each side, distal segment rather elliptical than rounded. Antennæ stout, shorter than the body; scale small, about as long as the rostrum, widest near the truncate tip; terminal spine small. Epistoma semicircular with a projecting median tooth. Third pair of maxillipeds hairy on the inner face. Chelæ strong, swollen and thickly punctate above inner border of the hand with a series of blunt serrations; movable finger squamoso-tuberculate on external border and with a prominent smooth rib above, tip incurved, brown and horny; outer finger stout, tip incurved and horny, also with a smooth rib above and with a nearly straight, denticulated inner border; tips of both fingers decurved. Carpus strong, deeply furrowed above, with a strong spine on the inner face and with two or more blunt tubercles on the distal end below. Second pair of legs quite hairy on the two or three terminal segments. Third pair of legs hooked. Fourth pair of legs with a rounded knob on the basal segment inside. First pair of abdominal appendages short, strong, twisted and consisting of two hook-like pieces one above the other; the upper hook, formed by the outer branch of the appendage is long, thin

and horny; the lower hook, formed by the inner branch of the appendage, is short, thick, and bears at its extremity a small outwardly directed tooth.

Male, Form II.—Similar; first abdominal appendages with an articulation at the base, the terminal hooks are shorter, blunt and swollen.

Female.—Chelæ smaller and weaker; annulus ventralis wider than long, anterior wall not present, posterior wall raised into a strong, sharp, transverse ridge; longitudinal fissure wide in front, but narrowing behind where it crosses the ridge.

Measurements of male, Form II.—Length, 71.5; carapace, 35; abdomen, 36.5; rostrum, 6; rostrum to cervical groove, 20.5. Breadth, carapace, 18; rostrum, 4.5; areola, 1; 2d abdominal segment, 17.

Indiana Localities.—Fall Creek, Indianapolis, Irvington, Marion county; Bloomington, Clear Creek, May's Cave, Monroe county; Down's Cave, Connelly's Cave, Lawrence county; cave near Paoli, Orange county; New Albany, Jefferson county.

As is seen, this species is frequently found in caves in company with the true cave crawfish, *C. pellucidus*. In fact the largest and best developed specimens I have ever taken have been in the limestone caves of Southern Indiana. It is to be looked for, however, in almost any spring or stream of clear running water where it hides under stones or digs short burrows into the banks. That this habit of living in cold water is not a fixed one, is shown by the fact that Dr. Faxon mentions specimens taken from a spring in Clarke county, Va., the temperature of whose water is 67°F.

The Indiana types differ from individuals from the Eastern United States in having a narrower areola, less spiny carpus, and shorter and broader rostrum.

Cambarus diogenes Girard.

Cambarus diogenes Girard, Proc. Acad. Nat. Sci. Phila., No. VI, p. 88, 1852.

Cambarus obesus Hagen, Ill. Cat. Mus. Comp. Zoöl., No. III, p. 81, 1870.

Cambarus diogenes Faxon, Mem. Mus. Comp. Zoöl., Vol. X, No. IV, p. 71, 1885.

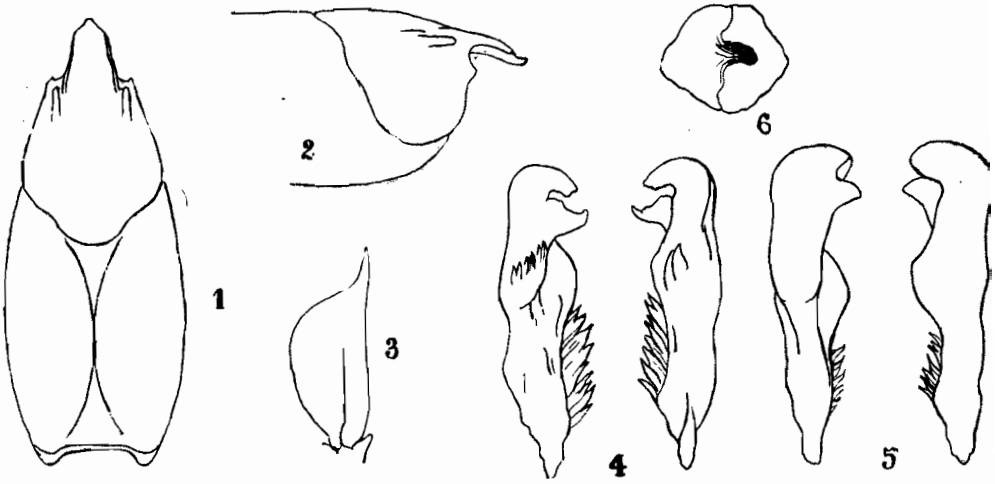

FIG. 7. *Cambarus diogenes.*—1 and 2, carapace from above and from the side; 3, antennal scale; 4, first abdominal appendage, male, F. I; 5, same, F. II; 6, annulus ventralis.

Male, Form I.—Rostrum short, broad, well excavated, down-curved, and without lateral spines; acumen short and triangular, its margins concave and the terminal spine turned abruptly upward. Post-orbital ridges low, grooved externally, swollen posteriorly, and without spines. Cephalothorax compressed, much contracted behind. Carapace smooth above, very lightly granulate on the sides; anterior border with a projecting angle just below the eye; cervical groove deep and sinuate, no lateral or branchiostegal spines. Areola linear, with a small anterior and a larger, poorly defined triangular area behind. First abdominal segment very narrow, second wider, about equal to carapace. Abdomen shorter than cephalothorax, pleural angles rounded; telson narrow, rounded behind, proximal segment bispinose on each side. Antennæ slender, shorter than the body, scale small, shorter than the rostrum, broadest at the middle. Epistoma triangular, the margins convex, as long as wide. Third maxillipeds with long hairs on inner face. Chelipeds large and strong, chelæ swollen and heavily punctate, inner margin of the hand tuberculate. External finger flattened on outer margin and with a row of dots along the inner margin close to the cutting edge, tip corneous and slightly incurved, cutting edge with a few tubercles; movable finger tuberculate at the base on both inner and outer margins, tip corneous and strongly incurved. Carpus short and thick, deeply furrowed above, with a small blunt spine on the inner surface and two small spines beneath. Meros thick and strong, with two small, blunt spines above and a double row of

small spines below. Distal joints (2) of second, fourth and fifth walking legs hairy. Third pair of legs hooked. First pair of abdominal appendages thick and short, ending in two recurved, falciform, teeth placed one above the other; the lower is large, strong and turned upward at the tip; it is formed by the inner part of the appendage; the upper tooth is thin and corneous.

Male, Form II.—Very similar, chelæ possibly a little smaller in proportion; first abdominal appendages with the teeth nearly equal in size, and blunt.

Female.—Similar, but with shorter antennæ, weaker chelæ, and broader and longer abdomen. Annulus ventralis about as long as wide, consisting of two interlocked irregularly crescentic portions which are raised around the margins into a prominent, rounded ridge. Openings of oviducts surrounded by a fringe of hair.

Measurements of male, Form I.—Length, 110; carapace, 57; abdomen, 53; rostrum, 11; tip of rostrum to cervical groove, 32; chela, 51.5. Breadth, carapace, 26; rostrum, 8; 2d abdominal segment, 20; chela, 22; areola, 0.

Color, a translucent, dark olive green, lighter and slightly flesh-tinted on the sides, margins of abdomen, rostrum and ends of chelae, red.

Indiana Localities.—Long Lake, Noble county; Kokomo, Howard county; Mechanicsburg, Henry county; Kankakee River, Riverside; Irvington, Marion county; Greencastle, Putnam county; North Salem, Hendricks county; Bloomington, Monroe county.

Cambarus diogenes will, in all probability, be found to occur in abundance in almost all portions of the State. It is a burrowing species, and with the next, *C. argillicola*, makes known its presence by raising above its burrows a chimney-like structure of mud pellets. The subterranean tunnels may sometimes be found to extend for several feet, and as the animal frequently excavates them at some distance from the water, they must reach a depth great enough to supply moisture sufficient for the needs of the animal. During the dry months of the summer, however, they seem to lie at the end of their burrows in a sort of stupor. I have seen them fall from the sides of an excavation apparently lifeless, but capable of reviving if put into water. In the early spring, when they come forth to breed, is the only season when they are a noticeable member of our fresh-water fauna. They move about chiefly at night, though I have frequently taken numbers of them from ditches and small streams on bright, sunny days. Of a lot of thirty-five specimens collected on the evening of April 2, 1892, twenty-nine were males and six were females. At this date they were in copulation. Eggs were laid from April 18th to 30th. I have frequently found females bearing well grown young in the small streams, and therefore do not think that the habit of burrowing is adopted as a protection to the young generation but rather to furnish a retreat during the dry summer months.

CAMBARUS ARGILLICOLA Faxon.

Cambarus argillicola Faxon, Proc. Amer. Acad. Arts and Sci., Vol. XX, pp. 115–116, 1884.

Cambarus argillicola Faxon, Mem. Mus. Comp. Zoöl., Vol. X, No. 4, p. 76, 1885.

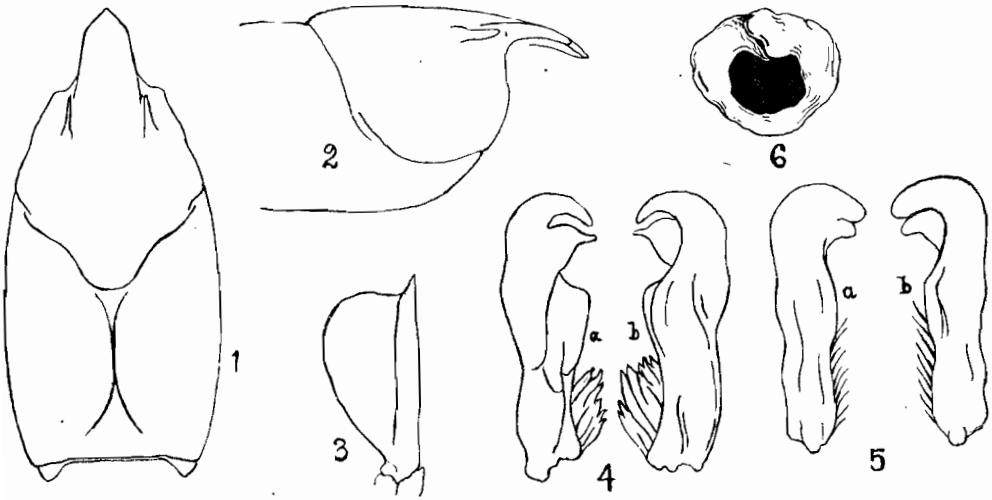

FIG. 8. *Cambarus argillicola.*—1 and 2, carapace from above and from the side; 3, antennal scale; 4, first abdominal appendages, male, F. I; 5, same, F. II; 6, annulus ventralis.

Male, Form I.—Rostrum short, broad, decurved, and well excavated, foveolate at base, edges raised, slightly converging toward the tip and then suddenly turning inward to form the triangular acumen, lateral teeth wanting. Postorbital ridges grooved externally and without spines. Carapace compressed, nearly smooth above, slightly granulate on the sides, and without lateral or branchiostegal spines, front border of carapace straight, no projecting angle below the eye. Cervical groove deep, sinuate, and broken on the sides. Areola obliterated in the middle, anterior triangular space very small, posterior space larger. Abdomen slender, about as long as the carapace, pleural angles rounded; proximal segment of telson bispinose on each side, distal segment rounded. Antennæ shorter than the body, scale small, shorter than the rostrum, broadest beyond the middle and truncate at the tip, terminal spine very small. Epistoma rounded or broadly triangular, with convex sides. Third maxillipeds hairy on inner and outer faces, the beard being long and abundant within and short and scant without. Chelæ large and strong; hand inflated and nearly smooth, inner border serrate, fingers flattened

and thickly punctate. Upper surface of movable finger with prominent ridge or rib bordered by a row of depressions; this finger, also, is cut out at the base and does not meet its fellow except for about the distal half of its length. Outer finger shorter than inner, not incurved, and usually bearded at the base. Carpus strong, deeply furrowed above, a large spine on inner surface and another on the lower surface near the distal end. Meros with a few very small spines above, near the distal end, and two rows of small tooth-like spines beneath. Two last segments of second pair of legs hairy. Third pair of legs hooked. First abdominal appendages consisting of two falciform teeth, of nearly equal length, placed one above the other, lower tooth thick and strong, upper tooth, formed by outer part of the appendage, thin, spatulate, and corneous.

Male, Form II.—Similar, but with weaker chelæ, which are almost always bearded. Abdominal appendages thicker, and with short, blunt teeth

Female.—Similar. Annulus ventralis with anterior border depressed to a level with the thoracic sterna, irregularly oval, consisting of a circular swollen ridge surrounding a deep depression, broken posteriorly by a narrow fissure.

Measurements of male, Form I.—Length, 71; carapace, 36.5; abdomen, 34.5; rostrum, 7; tip of rostrum to cervical groove, 23. Breadth, carapace, 17; rostrum, 5; areola, 0; second abdominal segment, 14.

Indiana Localities.—Irvington, Marion county; Bloomington, Monroe county; Wheatland, Knox county; New Albany, Jefferson county.

Cambarus argillicola is a small species resembling and very closely related to *C. diogenes*. Like its relative, it is a burrower, and builds mud chimneys over its holes. I have taken females with young as early as April 2.

As to the probable extent of this species in our State, it would be possible to say only this much: Dr Faxon's description was written from specimen's taken in Detroit, Mich., and I have received from Prof. A. A. Wright specimens from Oberlin, Ohio; so it would appear that the localities given by no means represent its distribution.

CAMBARUS INDIANENSIS SP. NOV.

Cambarus affinis var. Faxon, Proc. U. S. Nat. Mus. XII, p. 628, 1890.

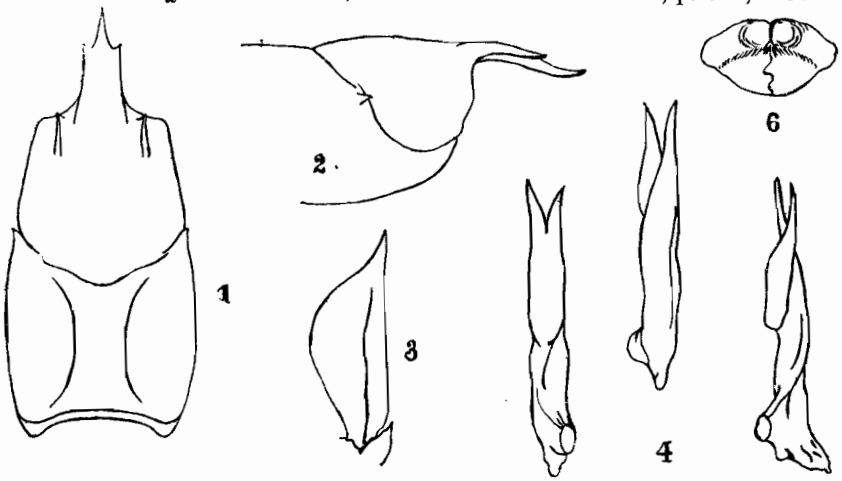

Fig. 9. *Cambarus indianensis.*—1 and 2, carapace from above and from the side; 3, antennal scale; 4, first abdominal appendage, male, F. I; 6, annulus ventralis.

Male, Form I.—Rostrum long, straight and well excavated, lateral spines acute and turned slightly outward. Acumen slender, sides concave, tip acute. Post-orbital ridges with a strong, acute spine. Carapace cylindrical, nearly smooth above, slightly punctate, sides slightly granulate, lateral spine prominent and acute, branchiostegal spine nearly obsolete. Cervical grove sinuate and broken on the sides. Areola wide. Abdomen a little shorter than the cephalothorax, pleural angles obtuse; telson tapering, rounded behind, proximal segment bispinose on each side. Eyes large and prominent. Antennæ shorter than the body, scale large, as long as rostrum, widest about the middle and curving gradually to the acute, somewhat outwardly directed terminal spine, basal joint of antennæ with a small acute spine. Third maxillipeds hairy on inner face. Chelipeds rather slender, chelæ rounded and smooth, very lightly punctate; fingers rounded, inner finger sinuate, outer finger slightly bearded at base, tips of both fingers in-curved. Carpus nearly smooth above, with a small internal and a still smaller inferior spine. Meros with two small spines above at the distal end and three or four similar ones on the inferior margin. Two distal segments of the second, fourth and fifth pairs of legs hairy. Third pair of legs hooked. First pair of abdominal appendages of medium length, terminating in two nearly straight, slightly diverging rami of nearly equal length, the outer ramus being slightly thicker than the inner.

Male, Form II.—Not known.

Female.—Similar to male except that the fingers are shorter and the beard on the hands is somewhat denser. Annulus ventralis small, hardly raised above the level of the thoracic sterna, wider than long, anterior wall faintly bi-tuberculate, longitudinal fissure narrow, posterior wall poorly defined, median depression shallow.

Measurements of male, Form I.—Length, 45.5; carapace, 22.5; abdomen, 23; rostrum, 7; rostrum to cervical groove, 15.5. Breadth—carapace, 10.5; rostrum, 3; areola, 2; second abdominal segment, 9.

Indiana Localities.—Patoka River, Patoka, Gibson county; Huntingburg, Dubois county.

Concerning the habits of this species I have been able to ascertain nothing. It probably is a form which frequents open waters much after the fashion of its close relative *C. affinis*, of the East, of which Dr. Faxon was at first inclined to regard this a variety.

Cambarus sloanii Bundy.

Cambarus sloanii Bundy, Bull. Ills. Mus. Nat. Hist., No. 1, p. 24, 1876.

Cambarus sloanii Faxon, Mem. Mus. Comp. Zoöl., X, No. 4, 1885.

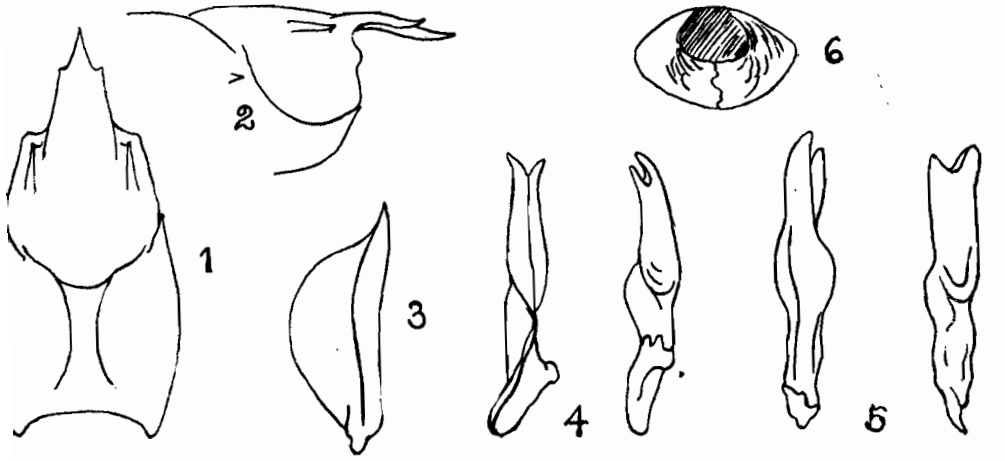

Fig. 10. *Cambarus sloanii.*—1 and 2, carapace from above and from the side; 3, antennal scale; 4, first abdominal appendage, male, F. I; 5, same, F. II; 6, annulus ventralis.

Male, Form I.—Rostrum long, wide, well excavated and with nearly parallel margins; lateral teeth usually prominent, but sometimes, in large individuals, almost obsolete; acumen long and slender. Post-orbital ridges short, spine small or wanting. Carapace cylindrical, slightly

flattened above, lightly granulate on the sides, lateral spine small but acute, front border of carapace notched just above the very small branchiostegal spine. Cervical groove very slightly or not at all sinuate, broken on the sides. Areola wide. Abdomen about as long as cephalothorax, pleural angles obtuse, basal segment of telson bispinose on each side, distal segment short and rounded. Antennæ slender, a little shorter than the body, scale a little longer than the rostrum, widest beyond the middle and curving gradually to the strong apical tooth. Epistoma triangular, notched in front and with raised convex margins. Third maxillipeds hairy on inner face. Chelæ short and thick, inner border with a double row of blunt teeth; outer finger furrowed above near the outer and inner margins, inner finger serrate on external (non-opposable) margin, opposable margins of both fingers beset with blunt teeth and touching only at their tips. Carpus with one large internal spine. Third pair of legs hooked. First pair of abdominal appendages thick, composed of two branches which are of nearly equal length and slightly twisted upon one another, free tips of these branches short, acute and horny, tip of outer branch turned outwards, tip of inner branch turned inwards; a large inwardly projecting knob at base of appendage.

Male, Form II.—Chelæ smaller, hooks on third pair of legs almost obsolete, first abdominal appendages thicker, free tips shorter and not horny, sometimes with an articulation near the base and without the large inwardly projecting knob.

Female.—Similar to male, Form II. Annulus ventralis oval, anterior border depressed, posterior border elevated and tuberculate, tubercle divided by a narrow longitudinal fissure.

Measurements of male, Form I.—Length, 55.5; carapace, 28; abdomen, 27.5; rostrum, 8; rostrum to cervical groove, 18.5; antennæ, 51. Breadth—carapace, 14; rostrum, 3.5; areola, 2; second abdominal segment, 11.5.

Indiana Localities.—New Albany, Floyd county; Madison, Jefferson county; Marengo, Crawford county.

This species is apparently quite abundant in southern Indiana, frequenting the muddy banks of running streams. Dr. Sloan, for whom the species was named, has made observations on its habits, as follows: "He commences on the bank of the stream, burrows below the bed, and has an opening two or more feet out in the stream, where he sits watching for anything that may turn up, with a safe retreat."

CAMBARUS PROPINQUUS Girard..

Cambarus propinquus Girard, Proc. Acad. Nat. Sci. Phila., VI., 88, 1852.

Cambarus propinquus Hagen, Ill. Cat. Mus. Comp. Zoöl., No. III., p. 67, 1870.

Cambarus propinquus Faxon, Mem. Mus. Comp. Zoöl., X. No. IV., p. 91, 1885.

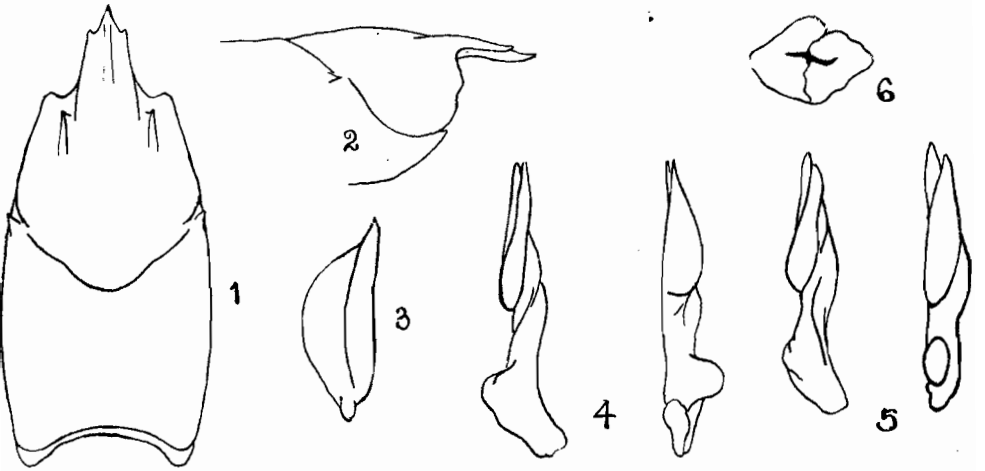

FIG. 11. *Cambarus propinquus.*—1 and 2, carapace from above and from the side; 3, antennal scale; 4, first abdominal appendages, male, F. I; 5, same, F. II; 6, annulus ventralis.

Male, Form I.—Rostrum long, narrow, well excavated, and with nearly parallel raised margins, acumen long, slender, and with concave sides, terminal spine acute, lateral teeth small. Just between the lateral teeth on the upper surface is a low longitudinal ridge. Post-orbital ridges short, grooved on the outer face, spine short and acute. Carapace cylindrical, smooth and punctate above, lightly granulate on the sides, lateral spines small. Cervical groove deep, hardly sinuate, broken on the sides, and ending just above the very minute branchiostegal spine. Areola broad and smooth. Abdomen strong, longer than carapace, pleural angles obtuse, telson tapering, proximal segment bispinose on each side, distal segment rounded behind. Antennæ stout, much shorter than the body, scale slightly longer than the rostrum, broadest near the middle and thence curving gradually to the acute terminal spine. Epistoma about as broad as long, sides convex and raised. Third pair of maxillipeds with inner face hairy. Chelæ rather short, rounded, slightly tuberculate on inner margin, nearly smooth above, movable finger sinuate, tips of

fingers incurved, brown and horny, outer finger sometimes slightly bearded at base. Carpus with a short, shallow furrow above, and with one strong spine on inner surface and another at the distal end beneath. Meros with one or two spines on the upper surface at the distal end and with two spines on lower surface. Distal joints of all the smaller legs more or less hairy. Third pair of legs hooked. First pair of abdominal appendages short and twisted, reaching nearly to the base of the second pair of legs, free tips rather long, slender and acute, tip of internal branch somewhat spatulate.

Male, Form II.—Similar to Form I, but with weaker chelæ and less carinated rostrum. First pair of abdominal appendages shorter, the branches swollen, the free tips short and blunt.

Female.—With shorter chelipeds. Rostrum sometimes without median carina. Annulus ventralis ovoid, anterior margin bi-tuberculate, posterior margin with a single low, median tubercle crossed by a narrow sinuous fissure, median depression crescentic, narrow and deep.

Measurements of male, Form I.—Length, 44; carapace, 21.5; abdomen, 22.5; rostrum, 6; rostrum to cervical groove, 14; antennæ, 33. Breadth—carapace, 11; rostrum, 3; areola, 2; second abdominal segment, 9.5.

Indiana Localities.—Delphi, Carroll county; Elkhart River, Noble county; Indianapolis, Irvington, Millersville, Marion county; Michigan City, Laporte county; Lake Maxinkuckee and Twin Lakes, Marshall county; Turkey Lake, Kosciusko county; Waterloo (Indian Lake), DeKalb county; Turman Creek, Sullivan county; Lafayette, Tippecanoe county; Clear Creek, Monroe county; Switz City, Greene county; Brookville, Franklin county; Salt Creek, Brown county. This is probably the most abundant species in our State. It is usually found in large numbers in the smaller streams hiding under stones, concealed in short burrows along the banks, or resting quietly on the bottom. I have been unable to obtain collections from the eastern counties of the State where possibly this species runs into the variety *sanbornii* Fax, which is distinguished from the typical form by the non-carinated rostrum, less deeply bifid abdominal appendages, pubescent chelæ and an inferior median anterior spine on the carpus. This variety has been collected in Carter county, Kentucky, and at Oberlin, Ohio, where, I am told by Mr. Lewis McCormick, it is, by far the most abundant species.

CAMBARUS VIRILIS Hagen.

Cambarus virilis Hagen, Ill. Cat. Mus. Comp. Zoöl., No. III, p. 63, 1870.

Cambarus virilis Faxon, Mem. Mus. Comp. Zoöl., X, No. 4, p. 96, 1885.

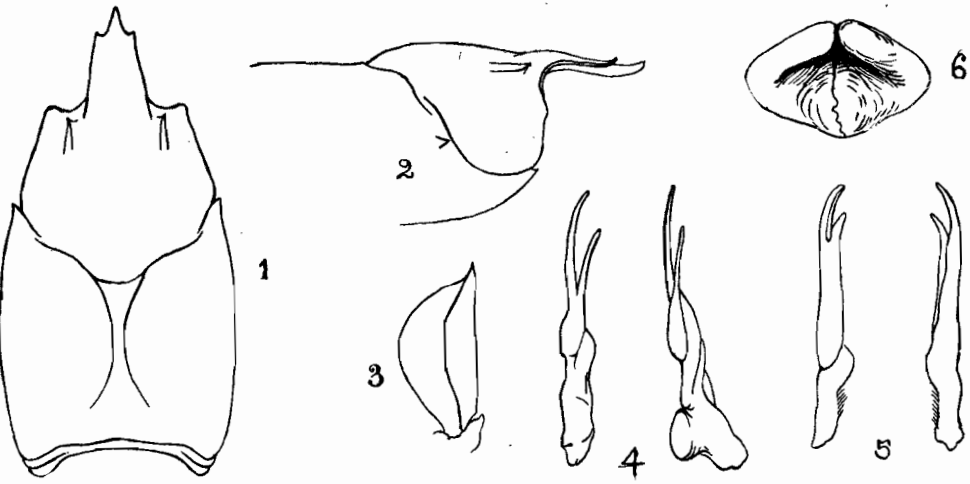

FIG. 12. *Cambarus virilis.* 1 and 2, carapace from above and from the side; 3, antennal scale; 4, first abdominal appendages, male, F. I; 5, same, F. II; 6, annulus ventralis.

Male, Form I.—Rostrum broad, long, well-excavated, and with raised converging margins; lateral teeth prominent and acute; acumen slender, sides concave, terminal spine sharp. Post-orbital ridges grooved on outer face, slightly swollen behind, and with an acute spine in front. Carapace cylindrical, smooth and thickly punctated above, granulate on the sides; lateral spine well developed, branchiostegal spine small; cervical groove deep, sinuate, broken on the sides; areola of moderate width, narrowest near the anterior end, strongly converging behind. Abdomen broad, as long as the cephalothorax; telson tapering; proximal segment bispinose on each side; distal segment short; posterior margin variable, rounded, straight or sinuate. Antennæ shorter than the body, scale as long as the rostrum, internal border rounded, widest about the middle; apical spine small. Third pair of maxillipeds hairy on the inner face. Chelipeds short and strong; chelæ broad and rather flattened; inner border of the hand and the movable finger biseriately tuberculate; both fingers strongly punctate above and with a pretty well defined smooth ridge; inner margin of outer finger straight, provided with strong tubercles and bearded; movable finger notched at the base. Carpus longer than wide, not very deeply furrowed above, with a strong spine

on the inner surface and two slightly smaller beneath. Meros with two small spines above near the distal end and a double row of acute spines on the lower border. Third pair of legs hooked. First pair of abdominal appendages very long, reaching to the base of the chelipeds, deeply bifid, the branches slender and slightly curved backward; the outer branch the longer, inner branch spatulate at the tip, which may be acute or blunt.

Male, Form II.—Similar, but with smaller and weaker chelæ; first pair of abdominal appendages usually articulated at the base, apex divided for but a short distance, branches cylindrical, blunt and nearly straight.

Female.—Similar. Annulus ventralis large, oval; anterior wall narrow, broken by the longitudinal fissure; posterior wall thick, elevated, crossed by a narrow, sinuous longitudinal fissure; median depression transverse, deep.

Measurements of male, Form I.—Length, 68; carapace, 33; abdomen, 35; rostrum, 8; rostrum to cervical groove, 21. Breadth—carapace, 16 5; rostrum, 5; areola, 1; second abdominal segment, 14.5.

Indiana Localities.—Elkhart River, Goshen, Elkhart county; Twin Lakes, Lima, Lagrange county; Rome City, Noble county; Lake Michigan, Michigan City, Laporte county; Long Lake, Noble county; Turkey Lake, Kosciusko county; Shelby, Lake county.

This species seems to be confined, in its distribution in Indiana, to the lakes and streams of the northern portion of the State. Here it is extremely abundant and attains a large size. I have seen specimens 120 mm. in length, and Professor W. F. Bundy records a length of 165 mm. In the lake regions of Wisconsin and Minnesota this species is said to be used extensively as food.

CAMBARUS IMMUNIS Hagen.

Cambarus immunis Hagen, Ill. Cat. Mus. Comp. Zoöl , No. III, p. 71, 1870.

Cambarus immunis Faxon, Mem. Mus. Comp. Zoöl., X No 4, p. 99, 1885.

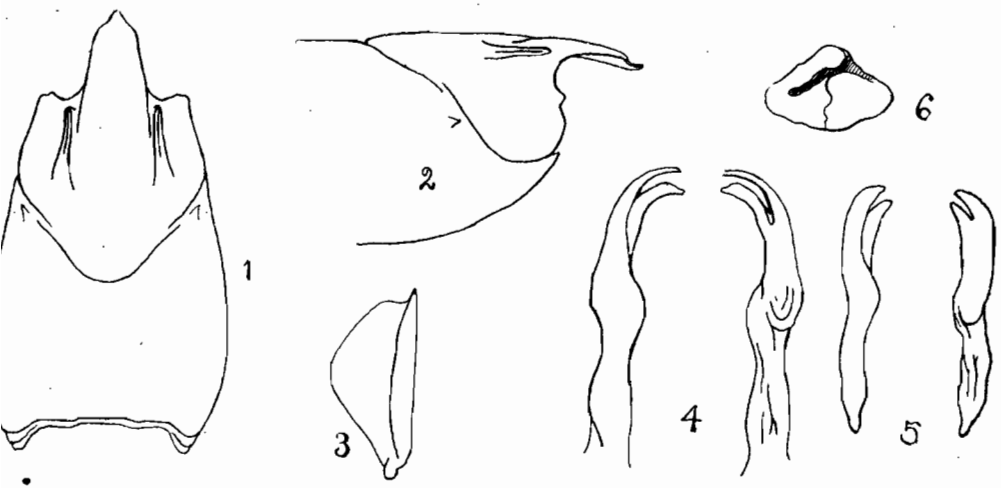

FIG. 13. *Cambarus immunis.*—1 and 2, carapace from above and from the side; 3, antennal scale; 4, first abdominal appendages, male, F. I, 5, same, F. II; 6, annulus ventralis.

Male, Form I.—Rostrum broad, long, well excavated, decurved, and with raised converging sides, usually with indications of a foveola at base; lateral teeth absent, acumen triangular with concave sides. Post-orbital ridges grooved on their outer faces, and without spines. Carapace smooth above, densely punctate, granulate on the sides, lateral spine present but very small, branchiostegal spine very small or wanting; cervical groove slightly sinuate, broken on the sides, areola narrow in the middle, anterior triangular space small, posterior space very large. Abdomen wide, longer than the body, pleural angles rounded; proximal segment of telson bispinose on each side, posterior border of distal segment slightly concave. Antennæ slender, shorter than the body, scale considerably longer than the rostrum, widest at the middle, truncate at the end, apical spine small. Epistoma triangular, notched in front, and with a minute median tooth, sides convex and raised. Third maxillipeds hairy on both inner and outer faces. Chelæ of medium size, variable in form, usually rather slender; internal border of hand and movable finger serrate, upper surface of both fingers with a smooth rib bordered on each side by a line of depressions, outer finger usually

bearded at base on inner border, movable finger usually excised at base inside and provided with a prominent tooth. Carpus deeply furrowed above, provided with several strong spines along the inner and lower aspects of the distal border. Meros with two weak spines above and a double row of stronger ones beneath. Second pair of legs with dense tufts of hair on the inner side near their extremities. Third pair of legs hooked. First pair of abdominal appendages reaching to base of second pair of legs, falciform, twisted, and deeply bifid, external branch the longer, its tip slender and acute, tip of inner branch flattened and spatulate; on a level with the base of the inner branch there is, on the outer side, a projecting shoulder.

Male, Form II.—Chelæ smaller and weaker; First abdominal appendages slender and less deeply divided, branches thick, blunt and less curved. Second pair of legs less hairy.

Female.—Similar to male, Form II; annulus ventralis ovoid, wider than long, depression lying far to one side, irregular (sigmoid) in form, walls raised and inflated, posterior wall crossed by a narrow fissure.

Measurements of male, Form I.—Length, 63; carapace, 30; abdomen, 33; rostrum, 7; rostrum to cervical groove, 19.5; antennæ, 51. Breadth, carapace, 16; rostrum, 4.5; areola, 1; second abdominal somite, 14 5.

Indiana Localities: White River, Fall Creek, Irvington, Marion County; Long Lake, Kendallville, Noble county; Wabash River, Posey county; Twin Lakes, Marshall county.

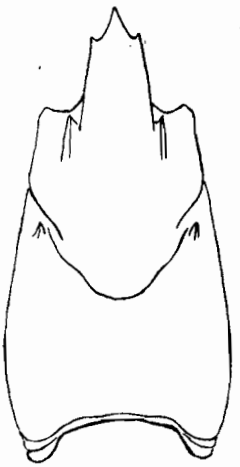

FIG. 13a.
Carapace of *Cambarus immunis spinirostris.*

This species is a mud lover, being found in great numbers in muddy ponds in the early spring. I have always found them in the greatest abundance in ponds which become perfectly dry during the summer months, but where the crawfish go during this time I have never been able to ascertain. Doubtless great numbers of them are eaten by birds and other animals, and great numbers of them perish, yet by the next spring they are as abundant as ever, and of about the same size.

From Prof. J. T. Scovell, of Terre Haute, I have received specimens which clearly belong to *Cambarus immunis spinirostris* Faxon, which differs from the typical form in the following characters: The rostrum with small but acute lateral teeth; post-orbital spines developed; lateral spines strong and acute; areola wider and slightly shorter in proportion to the anterior segment of the carapace; abdomen longer in proportion to carapace; antennæ longer than

the body. In the second-form males the tufts of hair on the second pair of legs are not at all developed, but in a large male of Form I they are very conspicuous. The first abdominal appendages of the males of both forms and the annulus ventralis of the female are like those parts in the typical form.

Indiana Locality—Streams of Vigo county.

CAMBARUS RUSTICUS Girard.

Cambarus rusticus Girard, Proc. Acad. Nat. Sci. Phila., VI, p. 88, 1852.

Cambarus rusticus Hagen, Ill. Cat. Mus. Comp. Zoöl., No. III, p. 71, 1870.

Cambarus rusticus Faxon, Mem. Mus. Comp. Zoöl., X, No. 4, p. 108, 1885.

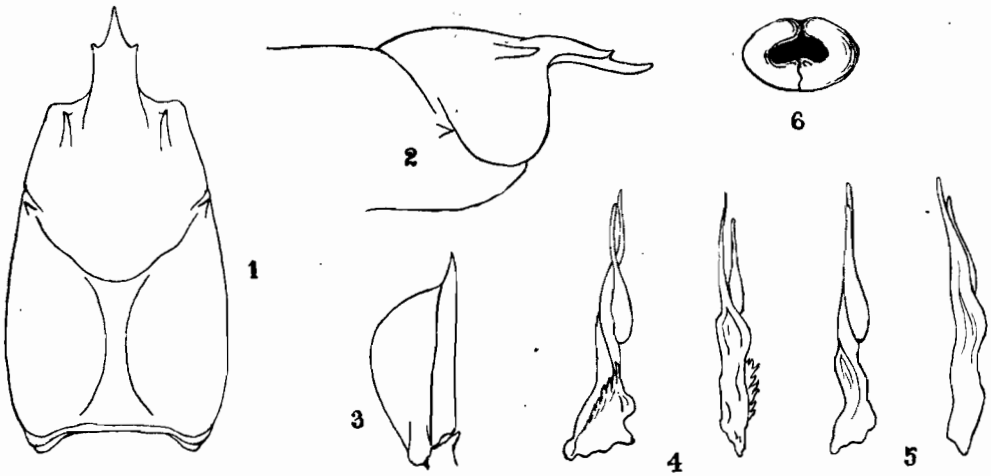

Fig. 14. *Cambarus rusticus.*—1 and 2, carapace from above and from the side; 3, antennal scale; 4, first abdominal appendages male, F. I; 5, same, F. II; 6, annulus ventralis.

Male, Form I.—Rostrum long, narrow, concave on sides and deeply excavated, margins raised, divergent at the base; acumen slender, terminal spine acute, upturned, brown and horny; lateral spines acute, upturned, brown and horny. Post-orbital ridges short, grooved on outer face, spines short. Carapace flattened above, smooth and punctate, granulate on the sides; lateral spine small, branchiostegal spine wanting; cervical groove deep, sinuate, broken on the sides; areola wide. Abdomen strong, as long as cephalothorax, pleural angles obtuse, telson

wide, basal segment bispinose on each side, distal segment rounded behind. Antennæ about as long as the body, scale as long as rostrum, widest beyond the middle. Epistoma triangular, sides convex, apex blunt. Third pair of maxillipeds hairy on inner face. Chelæ large and strong, inner border of hand and movable finger tuberculate, fingers and hand ornamented with lines of dots, fingers gaping at base, outer finger sometimes slightly bearded, movable finger sinuate, the tip incurved. Carpus strong, furrow on upper surface shallow, spine on inner surface small but strong, usually two strong spines beneath. Meros with two small spines above and two stronger, and sometimes several smaller ones beneath. Third pair of legs hooked. First pair of abdominal appendages long, twisted, deeply split and with slender branches; inner branch shorter than outer and not as slender.

Male, Form II.—Similar; first pair of abdominal appendages thicker, split for only a short distance and not slender and acute.

Female.—Very similar; annulus ventralis oval, bi-tuberculate in front, median depression deep, posterior wall raised into a tubercle which is divided by a very narrow sinuous fissure.

Measurements of male, Form I.—Length, 67; carapace, 34; abdomen, 33; rostrum, 9; rostrum to cervical groove, 22.5. Breadth, carapace, 18; rostrum, 4.5; areola, 2.5; second abdominal segment, 15.

Indiana Localities.—Waterloo, Dekalb county; Brookville, Franklin county; White River, and Irvington, Marion county; Ohio River, Jefferson county.

This species has very much the same habits as *C. propinquus* and the two are often found in company. *C. rusticus*, however, is much less common. It may be instantly recognized by the concave sides of the rostrum.

Cambarus putnami Faxon.

Cambarus putnami Faxon, Proc. Amer. Acad. Arts and Sci., XX, p. 131, 1884.

Cambarus putnami Faxon, Mem. Mus. Comp. Zoöl., X, No. 4, p. 118, 1885.

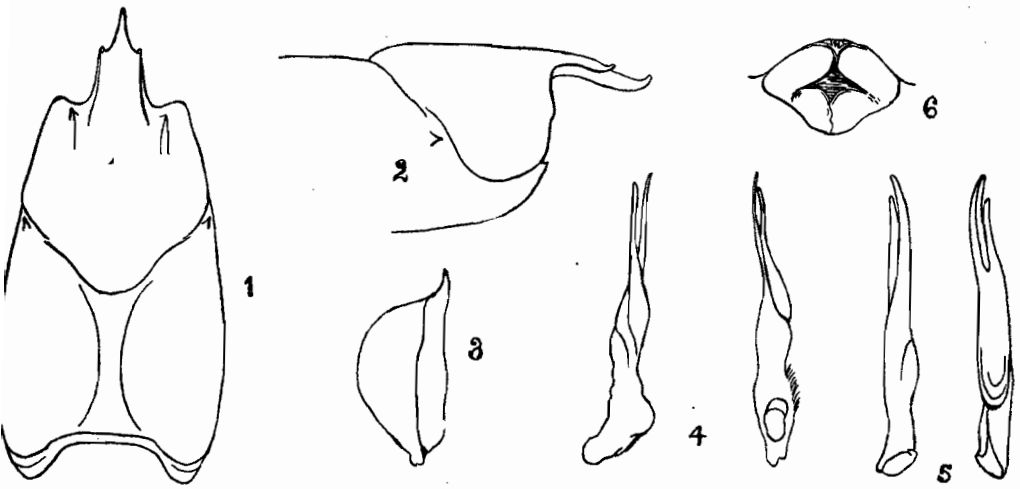

FIG. 15. *Cambarus putnami.*—1 and 2, carapace from above and from the side; 3, antennal scale; 4, first abdominal appendage, male, F. I; 5, same, F. II; 6, annulus ventralis.

Male, Form I.—Rostrum broad, well excavated, margins raised, nearly parallel in front, diverging behind; acumen long, slender, with concave sides, and terminated by an upturned, dark brown, horny spine; lateral spines strong, dark brown, horny. Post-orbital ridges short, grooved on outer face, swollen behind, terminated in front by a short, acute spine. Carapace somewhat flattened above, everywhere punctate, smooth or very lightly granulate on the sides, lateral spine small, branchiostegal spine minute or wanting; cervical groove deep, broad, broken on the sides; areola of moderate width, punctate. Abdomen as long as the thorax, pleura punctate, angles obtuse; sides of telson sinuous, proximal segment bispinose on each side, distal segment rounded behind. Antennæ slender, about as long as the body. Epistoma notched in front, sides convex and raised. Third pair of maxillipeds lightly bearded on the inner face. Chelipeds large and strong, chelæ large, external border convex, outer finger slender, inner finger sinuate, fingers gaping widely at the base, they and the hand thickly and deeply punctate above and below. Carpus strong, broadly furrowed above, with a strong spine on the inner face and two blunt spines on the lower surface. Meros with two small spines above, near the distal end, and one or two large blunt ones beneath. Third pair of legs hooked. First pair of abdominal appendages long and twisted, reaching to the base of the second pair of legs, deeply bifid, the branches slender; the outer branch is curved around to the inside and is the longer, the inner branch is curved toward the middle line, the tip is flattened and somewhat spatulate, base of the appendage with a projecting knob on the inner side.

Male, Form II.—Chelæ smaller; first pair of abdominal appendages articulated near the base, bifid only half as far as in form I, branches thicker, base without a projecting angle.

Female.—Chelæ shorter and wider, outer finger bearded within at the base. Annulus ventralis large, anterior wall bi-tuberculate, posterior wall raised and crossed by a narrow fissure, central depression transverse, deep.

Measurements of male, Form I.—Length, 102; carapace, 50; abdomen, 52; rostrum, 13; rostrum to cervical groove, 32. Breadth, of carapace, 27; rostrum, 6.5; areola, 2; second abdominal segment, 22.

Indiana Localities.—Bradford, Harrison county (?); Brookville, Franklin county.

In the Indiana State Museum there are two very large specimens of this crawfish for which no locality is given; it is probable, however, that they are from our State. In my own collection there is a small second-form male, collected between Paoli, Orange county, and Wyandotte Cave, which I refer with some doubt to this species.

LIST OF PAPERS TREATING OF THE SPECIES OF CRAWFISHES FOUND IN INDIANA.

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1844. Tellkampf. Mueller's Archiv., p 383.

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1870. Herman A. Hagen. "A Monograph of the North American Astacidæ." Ill. Cat. Mus. Comp. Zoöl., No. III.

1872. E. D. Cope. "Report on the Wyandotte Cave and Its Fauna," pp. 157–182, 3d and 4th Ann. Rept. Geolog. Survey Ind.

1873. A. S. Packard "On the Cave Fauna of Indiana," 5th Ann. Rept. Peabody Acad. Sci., Salem, pp. 93–97.

1874. S. I. Smith. "Crustacea of the Fresh Waters of the U. S.," U. S. Fish Comm. Rept., 1872–1873.

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1877. W. F. Bundy. "The Cambari of Northern Indiana." Proc. Acad. Nat. Sci., Phila , 1877, pp. 171–174.

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1891. W. P. Hay. "The Crustacea of Indiana." Proc. Ind. Acad. Sci., 1891, pp. 147–150.

1893. W. P. Hay. "Observations on the Blind Crayfishes of Indiana, with a Description of a New Sub-species; *Cambarus pellucidus testii.*" Proc. U. S. Nat. Mus., Vol. XVI, pp. 283–286.